PUBLIC HEALTH ASSESSMENT

POOLS PRAIRIE SITE
(a/k/a Neosho Wells)
NEOSHO, NEWTON COUNTY, MISSOURI
EPA FACILITY ID: MO0000958835

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Prepared by:

Missouri Department of Health
Section for Environmental Public Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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Glossary of Terms and Acronyms used in the Pools Prairie Public Health Assessment

Acute Exposure:
Contact with a chemical that happens once or only for a limited period of time. ATSDR defines acute exposures as those that might last up to 14 days.

Additive Effect:
A response to a chemical mixture, or combination of substances, that might be expected if the known effects of individual chemicals, seen at specific doses, were added together.

Adverse Health Effect:
A change in body function or the structures of cells that can lead to disease or health problems.

ATSDR:
The **A**gency for **T**oxic **S**ubstances and **D**isease **R**egistry. ATSDR is a federal health agency in Atlanta, Georgia that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.

Cancer:
A group of diseases which occur when cells in the body become abnormal and grow, or multiply, out of control

CERCLA:
See **C**omprehensive **E**nvironmental **R**esponse, **C**ompensation, and **L**iability **A**ct.

Chronic Exposure:
A contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than one year to be *chronic*.

Completed Exposure Pathway:
See **Exposure Pathway**.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA):
CERCLA was put into place in 1980. It is also known as **Superfund**. This act concerns releases of hazardous substances into the environment, and the cleanup of these substances and hazardous waste sites. ATSDR was created by this act and is responsible for looking into the health issues related to hazardous waste sites.

Concern:
A belief or worry that chemicals in the environment might cause harm to people.

Concentration:

How much or the amount of a substance present in a certain amount of soil, water, air, or food.

Contaminant:
See **Environmental Contaminant**.

Dermal Contact:
A chemical getting onto your skin. (see **Route of Exposure**).

Environmental Contaminant:
A substance (chemical) that gets into a system (person, animal, or the environment) in amounts higher than that found in **Background Level**, or what would be expected.

Environmental Media:
Usually refers to the air, water, and soil in which chemical of interest are found. Sometimes refers to the plants and animals that are eaten by humans. **Environmental Media** is the second part of an **Exposure Pathway**.

U.S. Environmental Protection Agency (EPA):
The federal agency that develops and enforces environmental laws to protect the environment and the public's health.

Exposure:
Coming into contact with a chemical substance.(For the three ways people can come in contact with substances, see **Route of Exposure**.)

Exposure Pathway:
A description of the way that a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical.

ATSDR defines an exposure pathway as having 5 parts:

1. Source of Contamination,
2. Environmental Media and Transport Mechanism,
3. Point of Exposure,
4. Route of Exposure; and,
5. Receptor Population.

When all 5 parts of an exposure pathway are present, it is called a **Completed Exposure Pathway**. Each of these 5 terms is defined in this Glossary.

Hazardous Waste:
Substances that have been released or thrown away into the environment and, under certain conditions, could be harmful to people who come into contact with them.

Health Effects:
ATSDR deals only with **Adverse Health Effects** (see definition in this Glossary).

Indeterminate Public Health Hazard:
The category is used in Public Health Assessment documents for sites where important information is lacking (missing or has not yet been gathered) about site-related chemical exposures.

Ingestion:
Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (See **Route of Exposure**).

Inhalation:
Breathing. It is a way a chemical can enter your body (See **Route of Exposure**).

MCL:
Maximum **C**ontaminant **L**evel. The highest level of a contaminant that EPA allows in drinking water. MCLs ensure that drinking water does not pose either a short-term or long-term health risk. EPA sets MCLs at levels that are economically and technologically feasible.

MRL:
Minimal **R**isk **L**evel. An estimate of daily human exposure - by a specified route and length of time -- to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used as a predictor of adverse health effects.

NPL:
The **N**ational **P**riorities **L**ist. (Which is part of **Superfund**.) A list kept by the U.S. Environmental Protection Agency (EPA) of the most serious, uncontrolled or abandoned hazardous waste sites in the country. An NPL site needs to be cleaned up or is being looked at to see if people can be exposed to chemicals from the site.

NOAEL:
No **O**bserved **A**dverse **E**ffect **L**evel. The highest dose of a chemical in a study, or group of studies, that did not cause harmful health effects in people or animals.

No Apparent Public Health Hazard:
The category is used in ATSDR's Public Health Assessment documents for sites where exposure to site-related chemicals may have occurred in the past or is still occurring but the exposures are not at levels expected to cause adverse health effects.

No Public Health Hazard:
The category is used in ATSDR's Public Health Assessment documents for sites where there is evidence of an absence of exposure to site-related chemicals.

PHA:
Public **H**ealth **A**ssessment. A report or document that looks at chemicals at a hazardous waste site and tells if people could be harmed from coming into contact with those chemicals. The PHA also tells if possible further public health actions are needed.

Plume:
A line or column of air or water containing chemicals moving from the source to areas further away. A plume can be a column or clouds of smoke from a chimney or contaminated underground water sources or contaminated surface water (such as lakes, ponds and streams).

Point of Exposure:
The place where someone can come into contact with a contaminated environmental medium (air, water, food or soil). For examples: the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, the location where fruits or vegetables are grown in contaminated soil, or the backyard area where someone might breathe contaminated air.

Population:
A group of people living in a certain area; or the number of people in a certain area.

Potential Exposure Pathway:
An exposure pathways with at least one of the five elements missing for a completed exposure pathway, but the potential exists for that element to be added allowing for exposure to a contaminant.

ppb:
Parts per billion. One part of chemical/pollutant per a billion parts of water.

ppm:
Parts per million. One part of chemical/pollutant per a million parts of water.

PRP:
Potentially **R**esponsible **P**arty. A company, government or person that is responsible for causing the pollution at a hazardous waste site. PRP's are expected to help pay for the clean up of a site.

Public Health Assessment(s):
See **PHA**.

Public Health Hazard:
The category is used in PHAs for sites that have certain physical features or evidence of chronic, site-related chemical exposure that could result in adverse health effects.

Public Health Hazard Criteria:

PHA categories given to a site which tell whether people could be harmed by conditions present at the site. Each are defined in the Glossary. The categories are:
- Urgent Public Health Hazard
- Public Health Hazard
- Indeterminate Public Health Hazard
- No Apparent Public Health Hazard
- No Public Health Hazard

Receptor Population:

People who live or work in the path of one or more chemicals, and who could come into contact with them (See **Exposure Pathway**).

Route of Exposure:

The way a chemical can get into a person's body. There are three exposure routes:
- breathing (also called inhalation),
- eating or drinking (also called ingestion), and
- or getting something on the skin (also called dermal contact).

Source (of Contamination):

The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first part of an **Exposure Pathway**.

Sensitive Populations:

People who may be more sensitive to chemical exposures because of certain factors such as age, a disease they already have, occupation, sex, or certain behaviors (like cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Superfund Site:

See **NPL**.

Toxicology:

The study of the harmful effects of chemicals on humans or animals.

Urgent Public Health Hazard:

This category is used in ATSDR's Public Health Assessment documents for sites that have certain physical features or evidence of short-term (less than 1 year), site-related chemical exposure that could result in adverse health effects and require quick intervention to stop people from being exposed.

PUBLIC HEALTH ASSESSMENT

POOLS PRAIRIE SITE
(a/k/a Neosho Wells)
NEOSHO, NEWTON COUNTY, MISSOURI

SUMMARY

The Pools Prairie site (formerly the Neosho Wells site) consists of six areas of volatile organic compound (VOC)-contamination south and east of the city of Neosho, Newton County, Missouri. Of the affected areas, Areas 1 and 2 are residential. In 1994 and 1995, VOCs were detected in private wells in Area 1 and in Area 2, respectively. Only trichloroethylene (TCE) and carbon tetrachloride were found above their respective Maximum Contaminant Levels (MCL) established by the Environmental Protection Agency (EPA). Wells in the two areas are used by residents as their potable water source. Investigations into the possible source(s) of the groundwater contamination found four potential source areas (SA-1 thru 4) located on the former Fort Crowder Military Reservation. The four source areas were part of a rocket engine manufacturing and testing operation that used TCE. Two of the areas were used to test engines and components and operated from approximately 1956 to approximately 1967 and 1973, respectively. The manufacturing building, built in approximately 1956, is still in operation. Operations at this building used TCE until approximately 1992. The 900 Building was used from approximately 1968 to 1992 for operations including the cleaning of engine fuel control components.

Residents with contaminated wells have been exposed to VOCs in the past through ingestion, inhalation, and dermal contact. To reduce residential exposure to the contaminated groundwater, bottled water was provided to more than 30 residences in 1995. In 1998, whole-house filtering systems were installed in the houses as an interim measure to eliminate exposure until a public water system could be installed. A public water system is in the process of being installed and, as long as all residences connect to the public water system, long-term exposure should be eliminated for those with contaminated and potentially contaminated private wells.

Because contaminant levels are unknown for past exposures (possibly from 1956 until the fall of 1995), and consequently the amount of exposure residents received from their potentially VOC- contaminated private wells for this time period is unknown, *the Pools Prairie site is classified as an Indeterminate Public Health Hazard for past exposures*. Because the exposure pathways were eliminated by the whole-house filtering system and, ultimately, by connection to the public water system, *the Pools Prairie site is currently classified as a No Apparent Public Health Hazard for residents connecting to the public water supply. For those not connected/connecting to the public water supply, the Pools Prairie site is currently classified as a Public Health Hazard. The Pools Prairie site is classified as A Public Health Hazard for the future* because: contaminated groundwater remains at the Pools Prairie site; some residents may not connect to the public water system and/or not properly maintain their whole-house filtration system; new wells may be drilled in the contaminated aquifer; the contamination plume may move or increase in concentration; and the source areas have yet to be remediated.

PURPOSE AND HEALTH ISSUES

In cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR), the Missouri Department of Health (DOH) is evaluating the public health impact of the Pools Prairie site. The Pools Prairie site was proposed by the Environmental Protection Agency (EPA) for its National Priorities List (NPL) on January 19, 1999, and finalized on September 17, 1999. This public health assessment determines

whether health effects are possible from exposure to contamination at this site and recommends actions to reduce or prevent possible health effects. ATSDR is a federal agency within the U. S. Department of Health and Human Services and is authorized by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) to conduct public health assessments at hazardous waste sites. This document will address past, current, and future exposure to the groundwater contaminated by the site.

BACKGROUND

The Pools Prairie site (formerly the Neosho Wells site) is located south and east of the city of Neosho in Newton County, Missouri. The site consists of six specific areas of volatile organic compound (VOC)-contamination. Four of the areas are potential source areas (SA-1 thru 4) where VOCs have contaminated the soil and groundwater. These source areas are located on the former Fort Crowder Military Reservation (Camp Crowder). The two other areas (Area 1 and 2) are residential areas where private wells are used for drinking water and the groundwater is contaminated with VOCs. These residential areas lie outside the Neosho city limits, but are adjacent to the former Fort Crowder area. One area of contaminated groundwater is located south of Neosho in the vicinity of the Highway 71 and Quince Road intersection (Area 1). The second area of contaminated groundwater (Area 2) is located east of Neosho along roads HH and TT and near the intersection of Highways 71 and 60 (See Figure 1 in Appendix A).

The Pools Prairie site was discovered in July 1994, when a resident complained to the Newton County Health Department (NCHD) about a leaking gas tank at a nearby truck stop. The resident was concerned that leaking gas might be affecting their well. Subsequent sampling of the well by NCHD indicated no gasoline contamination, but various VOCs were found including trichloroethylene (TCE) at 110 parts per billion (ppb) and carbon tetrachloride at 5.2 ppb. The levels of TCE and carbon tetrachloride exceeded the Environmental Protection Agency (EPA) Maximum Contaminant Levels (MCL) of 5 ppb for public drinking water systems. An MCL is the maximum permissible level of a contaminant in water which is delivered to any user of a public water system.

NCHD received additional requests from other nearby residents to have their wells sampled. Through subsequent sampling by NCHD, EPA, and the Missouri Department of Natural Resources (MDNR) during the fall of 1994 and the spring of 1995, all residential wells within a one-mile radius of the Quince Road and Highway 71 junction (Area 1) were sampled. Of the 45 private wells sampled, VOCs were detected in 12. TCE levels ranged from non-detectable to a maximum of 150 ppb, and carbon tetrachloride ranged from non-detectable to 5.2 ppb. Five of the wells had TCE contamination above its MCL. One well also had carbon tetrachloride contamination above its MCL. Chloroform, chloromethane, 1,1-dichloroethane, and cis-1,2-dichloroethene (DCE) were also detected in various wells, but were below levels of health concern (1,2).

In December 1994, MDNR requested that DOH evaluate the potential for human exposure to hazardous substances at the Pools Prairie site. On December 12-13, 1994, DOH personnel, along with personnel from MDNR's Division of Geology and Land Survey and the NCHD, conducted a site visit. The purpose of the site visit was to become familiar with the site, determine which residents were being affected, the extent of exposure to the residents, and to determine the possible source of the contamination.

In February 1995, DOH completed a Health Consultation on the Neosho Well site (later referred to as the Pools Prairie site) under a cooperative agreement with ATSDR (2). The health consultation recommended that:

- an alternate source of water or a whole-house treatment system be provided to the residents with contaminated wells to prevent continued exposure;

- further investigation be conducted to determine if other residents were exposed;

- the known contaminated wells be monitored for changes in the contamination level; and,

- the source of contamination be determined to prevent other residents from being affected.

In July 1995, the U. S. Army Corps of Engineers began providing bottled drinking water to those residences with wells containing TCE equal to or above its MCL. TCE was used as the indicator chemical because it was the major contaminant found in the private wells where MCLs were exceeded.The bottled water was intended to be a short-term response action to reduce residents' exposure from the ingestion of contaminated water until a long-term uncontaminated water supply could be provided (3).

DOH personnel attended an MDNR public availability session on August 22, 1995, to present the health consultation to the public, gather community concerns, respond to health questions from the community and provide community health education. The other agencies involved in the investigation were present to share information with the public, answer their questions, exchange information about the site, and determine if there were additional residences that needed bottled water.

From October 1995 to May 1996, EPA and MDNR expanded water sampling in Area 1 and began extensive private water well sampling (approximately 145-150 wells) in the Highway HH and TT area. This additional sampling was conducted to further determine the extent of contamination and to determine if residents were being exposed. This expanded sampling resulted in the discovery of the second area (Area 2) of TCE groundwater contamination in the Highway HH and TT area, located east of Neosho (See Figure 1). Information about the source areas that potentially contributed to this contamination will be discussed later under the Source Areas section. By May 1996, approximately 220 private and public drinking water wells from both areas had been sampled by the different agencies. Additional sampling of another approximately 30 wells by EPA since the fall 1996 has increased that number to approximately 250 wells (3).

In Area 1, the level of TCE contamination detected in private wells ranged from non-detectable to a maximum 150 ppb and carbon tetrachloride ranged from non-detectable to a maximum of 5.2 ppb. Samples taken after bottled water was provided by the Corps of Engineers in February 1997, found that the level of TCE in the original well had risen from 150 ppb to 180 ppb (4). The maximum level detected was in a sample collected by MDNR in 1996 that contained 310 ppb TCE and 8.4 ppb carbon tetrachloride (5). However, split sample results were not consistent, suggesting a possible problem with the quality control of this sample. In Area 2, TCE concentrations ranged from non-detectable to a maximum of 83 ppb (3). Considering the karst geology of the area, it may be impossible to determine if these groundwater contamination levels is the maximum that has been or will be present. Refer to the Geology Section for a better explanation about the karst geology. See Table 1 for a summary of contaminants and their levels detected in private wells.

According to an October 1997 Engineering Evaluation/Cost Analysis for the Pools Prairie site, there are 36 private wells (9 in Area 1 and 27 in Area 2) that exceed the MCL for TCE. Other wells have detectable TCE and other VOC contamination, but the levels are below levels of health concern (3).

Table 1. Summary of Maximum Levels of Chemicals Detected in Private Wells at the Pools Prairie Site in parts per billion (ppb)

Chemicals (MCLs = 5 ppb)	**TCE**	**Carbon Tetrachloride**
Area		
Area 1 (Hwy 71 and Quince Road area)	ND to 110 (1994) ND to 150 (1994-95) ND to 310 (1996)* ND to 180 (1997)	ND to 5.2 (1994) ND to 5.0 (1994-95) ND to 8.4 (1996)* NR (1997)

Area 2 (Hwy HH and TT area)	ND to 83	ND to 4.0

ND = Not Detected
NR = Not Reported
* = Split sample results were not consistent, suggesting a possible problem with quality control of the sample.
MCL = EPA's Maximum Contaminant Level

On May 21, 1997, DOH/ATSDR completed an EPA-requested health consultation to indicate what level of TCE contamination in residential wells should trigger the installation of a whole-house water supply to protect the health of residents at the Pools Prairie site. The health consultation reconfirmed the February 1995 health consultation statement that residents whose private wells had contamination that exceeded EPA's MCL should be provided with an alternative whole-house source of water to completely eliminate exposure (6).

On July 31, 1997, DOH/ATSDR released an MDNR-requested health consultation on what would be considered the most protective method of supplying a safe, whole-house water supply to residents to completely eliminate exposure. DOH recommended that a public water system would be the most effective method to prevent exposure to residents with contaminated wells and those that could potentially be affected equally (7).

On February 25, 1998, EPA and MDNR reached an agreement with the potentially responsible parties (PRPs) to provide whole-house treatment units for residences whose private wells had TCE contamination equal to or above the MCL. The treatment units were to replace the bottled water and provide an interim solution until a decision could be made on a long-term water supply (8). Thirty-four in-house filtration systems had been installed by April 14, 1998 (9).

In December 1998, the EPA and MDNR completed an agreement with the PRPs that provides for a long-term water supply to areas affected or potentially affected by the Pools Prairie site (See New Service Areas on Figure 1). Work on the public water system is underway and is projected to be completed in the year 2000. Residences that were in existence prior to the effective date of the Administrative Order of Consent (December 1998) will be given the opportunity to connect to the public water system at no cost to home owners (10).

Although these residents will be given the opportunity to connect to the public water system for no cost, some have already declined connection to the system and will continue to use their contaminated or potentially contaminated private wells. The Administrative Order of Consent does not require the abandonment of existing wells (11).

Source Areas

Through investigations to find the cause of the TCE groundwater contamination in Area 1 and Area 2, four potential source areas were identified. The potential source identified for Area 1 was the 900 Building on the former Fort Crowder Army Base. The expanded private well sampling found contamination in wells of the HH and TT area that potentially could be from three different sources. All four of the potential sources are located on the former Fort Crowder Army Base (See Figure 1).

Fort Crowder was built in 1941 as a training center for the U. S. Army Signal Corps, and at its peak had nearly 47,000 troops stationed there. Fort Crowder was completely deactivated in 1958, and was declared surplus property in 1962 (1). In approximately 1957, the Army transferred a portion of Camp Crowder to the Air Force for construction of a rocket engine manufacturing plant. This installation was known as Air Force Plant No. 65. Construction of Plant 65 began in approximately 1956, with operation beginning in 1956 or 1957. Besides the main manufacturing plant, construction also included an area initially used to test-fire rocket engines (now referred to as the Engine Testing Area or ETA), an area for testing components related to rocket engines (now referred to as the component testing area or CTA), and a former Camp Crowder

building, initially used as a warehouse, but later used for engine overhaul and manufacturing purposes (now referred as the 900 Building) (12). In the EPA's January 19, 1999, proposal to add the Pools Prairie site to the NPL, they list the Pools Prairie site as having five potential sources for groundwater contamination. The CTA site and the CTA's contaminated soil are listed separately (two separate sources) (13). For the purpose of this public health assessment, we will consider the CTA as a single source area.

900 Building/Source Area 1 (SA-1)

Based on reports from citizens, it was determined that the 900 building was a potential source of TCE contamination for the Quince Road and Highway 71 site. Refer to Figure 1 for the location of the 900 Building (SA-1). The 900 Building was used for a laundry facility for Camp Crowder until the Korean War. It was then used, from 1956 to 1968, to dismantle and store engines in association with their testing and production at the manufacturing plant and Test Site. From 1968 to 1992, the building was used for operations including the cleaning of engine fuel control components. According to a 1997 removal assessment report to the EPA, a number of citizens have reported that TCE was used in the 900 Building during that time (1968-1992) and waste TCE was deposited on the ground for weed control. The 900 Building is presently used for storage (14).

Sampling at the 900 Building in 1997 found TCE at a maximum concentration in the subsurface soil at 537,000 ppb (reported value was not validated by approved quality control (QC) procedures). Elevated levels were not detected in the surface soils. Groundwater samples found TCE at a maximum of 4,200 ppb in a monitoring well at the 900 Building (15). On May 5, 1999, an agreement was reached to address soil and groundwater contamination around the 900 Building and the Quince Road area. The agreement requires following: an engineering evaluation/cost analysis (EE/CA) be done to evaluate various cleanup alternatives;a risk assessment be completed to identify the risk that the chemicals pose to humans and the environment; and, to determine if further investigations are needed. This information will be used to make decisions about cleanup actions necessary in the Quince Road area (15).

Engine Test Area (ETA) and Component Test Area (CTA)

The test area (ETA and CTA) was first investigated in a preliminary assessment/site investigation (PA/SI) in July 1986. The 1986 investigation determined that waste management practices had caused low-level contamination at the site, but based on off-site sampling, there appeared to be no contaminant migration from the facility (16). In December 1993, a more in-depth investigation of the test area found contamination in the soil and groundwater at the ETA and CTA. The report recommended that additional investigation of the groundwater flow system be conducted (17). More recent dye trace studies (initiated 1996) from both the ETA and CTA have shown a hydrogeologic connection between them and the area of contaminated wells along Hickory Creek (Area 2) (2).

Engine Test Area (ETA)/Source Area 2 (SA-2)

The ETA (SA-2 on Figure 1) was used by a U.S. Air Force contractor to test rocket engines from approximately 1956 to approximately 1967. Newly assembled rocket engines were tested in an area that consists of two bunkers equipped with rocket blast deflectors and concrete waste liquid drainage ditches (troughs) leading to a series of storage ponds. During the main period of operation, several train tanker cars of liquid rocket fuel were delivered and used per week. Operations created large quantities of waste fuels and lubricants; however, no record exists of the exact amount. After completion of the performance tests, the rockets were drained of any remaining fuel. The fuel, any lubricants that were used, TCE, methyl alcohol, hydrazine, and other waste products, were allowed to flow via concrete drainage ditches (troughs) to a hazardous waste pit and storage lagoons. After a large volume of waste liquids had accumulated, the storage lagoons were burned off. These fires created large clouds of black smoke that created concerns about air

pollution and the practice was halted. After the practice of burning was stopped, waste liquids were sold to an asphalt company. Also, unknown quantities of waste TCE were sold to a chemical company for recycling. In approximately 1967, the ETA was closed and abandoned (2, 16, 18). In 1981, the lagoons were pumped dry and filled with soil (2).

VOC contamination was found in investigations at the ETA site since 1986, but none of the studies focused on the waste pit. In August 1996, EPA sampled the pit and surrounding area, and determined that high concentrations of contaminants remained in the pit. A liquid sample taken at the 16-18 foot depth revealed 25% (250,000,000 ppb) TCE, 4% (43,000,000 ppb) 1,2-dichloroethylene, and almost 1% (910,000 ppb) vinyl chloride. Soil samples from the same depth revealed TCE at 1,500,000 ppb, along with other VOCs. Results reported from a single monitoring well indicated that groundwater was contaminated with 4,200 ppb TCE, 1,600 ppb 1,2-dichloroethylene, and 34 ppb of vinyl chloride (19). During the February 1999 site visit, remedial activities were underway and the waste pit had been covered to prevent water infiltration. Remediation continued through the fall of 1999 with liquids being pumped from the pit and stored on site for later disposal (20).

Component Test Area (CTA)/Source Area 3 (SA-3)

At the CTA (SA-3 on Figure 1) tests were performed on rocket components, such as gas generators, turbo pumps, and vernier engines until 1967-68 when the mission of Plant 65 changed. A different contractor began using the CTA to test small turbo-jet engines. In 1970, another company took over the operation using the site for identical purposes until it closed the site in 1973. In 1976, the U.S. Government sold the CTA portion of the Test Site to the Water and Wastewater Technical School, Inc. (16, 21).

During the time of operation of the CTA, waste liquids were routed to primary and secondary storage lagoons and/or a hazardous waste pit. In 1981, the storage lagoons were pumped dry and the liquids disposed of on site. The storage lagoons were destroyed by bulldozing the existing berms. Sampling performed between October 1991 and January 1993 found TCE in soil at a maximum concentration of 5,910,000 ppb and TCE in groundwater from a monitoring well at a maximum of 200,000 ppb (17). Dye tracing performed in 1996, by the Missouri Department of Natural Resources, Division of Geology and Land Survey (DGLS) confirmed a pathway from the secondary lagoon to Gibson Springs (located approximately 10,500 feet to the north-northeast) (21). On August 27, 1998, EPA reached an agreement with the PRP to address soil and groundwater contamination at the CTA site. The PRP agreed to reduce storm water infiltration into the hazardous waste pit, install a system to contain and treat contaminated groundwater, and conduct an engineering evaluation/cost analysis to identify and evaluate long-term alternatives to address contaminated soil (22). During the February 1999 site visit, remedial activities were observed to be in progress. Remediation continued through the fall of 1999 with contaminated groundwater being pumped from the site, treated, and discharged (20).

Manufacturing Facility/Source Area 4 (SA-4)

The Manufacturing Facility (SA-4 on Figure 1) was built in 1956 and used to make rocket engine parts and assemble rocket engines. Manufacturing processes performed included machining, welding, heat treatment, plating, degreasing, and final assembly. After being purchased by a new owner in 1968, the facility was used to overhaul jet engines. Although, ownership has changed, the facility has continued to be used for that purpose through the present. TCE is believed to have been used by the previous owners. The current owners have used perchloroethylene (PCE, also known as tetrachloroethylene) since September 1992 and have used 1,1,1-trichloroethane (TCA) in the past. Soil samples collected by MDNR in January 1996 found low levels of TCE contamination (maximum of 690 ppb) (2). Additional sampling begun by EPA in 1998 to better determine the extent of contamination has been completed. TCE was found at a maximum level of 3,700,000 ppb in subsurface soils (23). Monitoring wells have been installed to determine the extent of groundwater contamination. Results are not available at this time.

Geology

The Neosho area is underlain by limestone bedrock. This limestone formation is considered karst, with caves, losing streams, and springs. Little research has been conducted into the actual groundwater flow patterns through the karst materials from the source areas. Dye tracing has indicated that groundwater from the CTA and ETA reappeared in springs (1). At the CTA site, a conceptual site model indicates that VOC-contaminated soil has affected the perched groundwater in the karst area and that downward flow over time through the bedrock and/or rapid flushing in response to storm events through conduits in the bedrock has contaminated the groundwater and springs (21). This model may or may not apply to the other source areas.

Upper and lower aquifers exist in the area, separated by a regional confining unit made up of shaley limestone and shales. Thickness of this confining layer varies from 25 to 40 feet. Private wells in the area range in depth from 35 to 525 feet. The wells that penetrate the deep aquifer are almost always open to both aquifers. Groundwater from the shallow and deep aquifer is a highly used resource. Wells in both the shallow and deep aquifers have shown TCE contamination (1). The shallow aquifer (less than approximately 300 feet deep) has shown TCE contamination from non-detectable to a maximum of 310 ppb. The deep aquifer (greater than approximately 300 feet deep) has shown TCE contamination ranging from non-detectable to 11 ppb (3).

Demographics

The 1990 population of Neosho was 9,254 with the population of the city's zip code (64850) being 15,847 (24, 25). Within one mile of the two areas of groundwater contamination (Area 1 and 2), the population is 1,778. Most of these residents would be using private wells and have the potential to be exposed if their private wells became contaminated. Of that potentially exposed population (1,778), 97% are white, with the remaining 3% representing various minorities. Children six years and younger represent 12.8% of the population and those 65 and over account for 11.5% of the population. Women of child-bearing age between the ages of 14 to 44 account for 23% of the population (26).

Site Visits

Numerous site visits have been made to the site and surrounding areas by personnel of DOH, including the initial site visit in December 1994. The most recent site visit of the area, including the ETA and CTA, occurred on February 10, 1999. The site visit consisted of visiting the ETA and CTA sites to observe the remedial activities taking place to prevent further contamination of groundwater. Some of the activities included the modifications of drainage systems, the addition of covers to prevent water movement through contaminated materials, and the installation of monitoring wells to measure groundwater contamination and its movement. During earlier site visits by DOH personnel, it was evident that trespassing had occurred on the ETA and CTA sites, but the 900 Building and the Manufacturing Facility are fenced and secure. During the February 1999 site visit of the ETA and CTA, security had increased, the remedial work was in progress, and signs of recent trespass were not evident. Also a fence is being installed through the woods at the CTA to prevent Missouri National Guard personnel from wandering onto the site from an adjoining area.

Land Use

The southern portion of the Pools Prairie site is located on relatively flat prairie land that gives way to a more rolling woodland to the north. The property that was once Fort Crowder has been converted to an industrial park and the closed Newton-McDonald County Landfill on the southern portion. The northern portion is more remote. Part of this area is used by the Missouri National Guard for training. No residences are located on the old Fort Crowder property, but homes with large sized lots adjoin the property on the north. On the western side a combination of residential and small businesses lie along US Highway 71. To the south and

east are scattered large acreage farmsteads that consist of pastureland and some crop land.

PUBLIC HEALTH ASSESSMENT

POOLS PRAIRIE SITE
(a/k/a Neosho Wells)
NEOSHO, NEWTON COUNTY, MISSOURI

DISCUSSION

Pathways Analysis

To determine whether the residents living in the areas of contaminated groundwater are exposed to contaminants, DOH evaluated the environmental and human components that lead to human exposure. This pathways analysis consists of five elements that ATSDR considers necessary for a completed exposure pathway. The five elements are a source of contamination, transport through an environmental medium, a point of exposure, a route of human exposure, and an exposed population. An exposure pathway can be eliminated if at least one of the five elements is missing and will never be present. Completed pathways require that the five elements exist and indicate that exposure to a contaminant has occurred in the past, is currently occurring, or will occur in the future. Potential pathways, however, require that at least one of the five elements is missing, but could exist. Potential pathways indicate that exposure to a contaminant could have occurred in the past, could be occurring now, or could occur in the future (27).

Completed Exposure Pathways

Completed exposure pathways existed at the Pools Prairie site until whole-house filtering systems were installed in residences with known trichloroethylene (TCE) contamination above EPA's MCL. Completed exposure pathways still exist in some residences, but levels are below the MCL. The sources of the contamination are the four potential source areas located on the old Fort Crowder property where past releases and improper disposal of TCE occurred. The environmental medium is contaminated groundwater. The point of exposure is at residences that have contaminated private wells. The routes of exposure include ingestion, inhalation, and skin contact. The exposed population is the people using contaminated well water. The time frame for the completed exposure pathway was in the past when residents used contaminated private wells as their sole source of potable water.

Presently, residents with private well contamination above the MCL have been provided with whole-house filtering systems and are no longer exposed to contaminated water. The installation of the public water system should provide a long-term solution and eliminate exposure pathways for those residents presently on whole-house filtration systems and all others in the new service areas (See Figure 1) as long as residents connect to the system. For those that don't connect to the public water system and have wells contaminated above the MCL, a completed current and future exposure pathway exists. For those with whole-house filtration systems, a completed future exposure pathway will exist if the units are not properly maintained. In addition, if wells outside the public drinking water system become contaminated, a future completed exposure pathway will exist.

Potential Exposure Pathways

Present and future potential exposure pathways exist. Because the contamination remains in the groundwater at the Pools Prairie site, it is possible for residents to be exposed in the present and future if contamination in private wells increases above the MCL or the plume migrates and impacts additional wells. The installation

of the public water system should eliminate potential exposure pathways in the two areas (Area 1 and 2) as long as residences connect to the system. Additional potential pathways could exist if the contamination plume moves into an area of private wells outside of the new public water service area where TCE has not been previously detected, or if new wells are drilled into areas of potential groundwater contamination (no drilling restrictions are in place).

There is the potential for exposure at the different contaminated source areas because the contamination is still present. Exposure could occur to remediation workers, the possible trespasser, others who may occupy or work on the site, or if the area is developed or used for another purpose before it is completely remediated. Since SA-2 and SA-3 at the test center are remotely located and somewhat secured, little unauthorized access is expected, although trespass has occurred in the past. Direct contact with highly contaminated materials is a potential source of exposure. Because contamination is located below the surface of the soil, remediation workers are the most likely to be exposed. Workers are expected to use the appropriate personal protection equipment to prevent that exposure. SA-4 is fenced and access is limited only to employees. Surface soil contamination levels detected so far at SA-4 do not pose a health concern. SA-1 is fenced and access is limited. Exposure through contact with the contaminated surface soil is not expected to cause health effects.

TOXICOLOGICAL EVALUATION

Introduction

This section will discuss the health effects of exposure to specific contaminants. To evaluate health effects, ATSDR has developed a Minimal Risk Level (MRL) for contaminants commonly found at hazardous waste sites. The MRL is an estimate of daily exposure to a contaminant below which non-cancer, adverse health effects are unlikely to occur. MRLs are developed for each route of exposure, such as ingestion and inhalation, and for the length of exposure, such as acute (less than 14 days), intermediate (15 to 364 days) and chronic (greater than 365 days) (27).

TCE and carbon tetrachloride are the major contaminants found in private wells at the Pools Prairie site. Other chemicals have been detected during the sampling of private wells, but were found to be below their MCL or not at a level of health concern. Exposure doses were calculated using the maximum level of the contaminant detected (310 ppb) and, in the case of cancer, for the maximum length of time of possible exposure (lifetime of exposure, 70 years). To date, it is unlikely that any residents were exposed through ingestion and inhalation to those levels of contamination for that length of time. However, the known maximums were used to consider the worst-case exposure for those residents who may potentially have contaminated wells outside the public water supply distribution area and residents not connecting to the public water supply.

The pathways of ingestion and inhalation are the major pathways of exposure at the Pools Prairie site. Dermal contact with concentrated levels in an occupational setting has been found to cause health effects, consisting mostly of dermatitis, and some individuals can develop hypersensitivity to the chemicals (28). However, dermal contact with TCE and carbon tetrachloride at the levels present in residential wells are much lower than the levels reported in occupational settings, and do not pose a health concern. A discussion of TCE and carbon tetrachloride through the ingestion and inhalation routes of exposure and their possible health effects are presented below.

Trichloroethylene

Exposure through ingestion, inhalation, and dermal contact to TCE-contaminated groundwater above EPA's MCL has occurred in the past, is presently occurring at levels below the MCL, and exposure may occur in the future to residents not connected to or outside the new public water system being installed at the Pools Prairie

site. TCE was used from 1956 to 1992 at SA-1, from 1956 to 1967 at SA-2, from 1956 to 1973 at SA-3, and from 1957 to 1992 at SA-4 (all dates are approximate). It is believed that TCE was used in large quantities at the different source areas, especially SA-2 and SA-3.

Residents could have been exposed to TCE-contaminated groundwater since the startup of operations in 1956-57, but exposure starting a number of years later is probably a more accurate estimate. In Area 1, the level of TCE has increased from 110 ppb in 1994 in the original private well, through 150 ppb in early 1995 to 180 ppb in 1997. This may indicate that the TCE has gradually been increasing over the years and that residents have not, until recent years, been exposed to these higher levels. In Area 2, levels of TCE have not been as high as in Area 1, but past levels are not known.

People can be exposed through ingestion by drinking contaminated water. Ingestion exposures were calculated using the maximum value of TCE (310 ppb) detected in private wells to determine the worst-case daily ingestion exposure dose for adults and children (see Appendix B). Ingestion exposure at this level is not expected since that level was detected in August 1996 after bottled water had been provided in July 1995. Due to insufficient data, ATSDR does not have intermediate and chronic ingestion guidelines for TCE. In reviewing the available literature on chronic exposure (greater than 365 days) to TCE through ingestion, all the animal studies found used much higher doses than the exposure dose calculated for this site. The lowest No Observed Adverse Effect Levels (NOAELs) dose found in chronic animal studies (50 milligram/Kilogram/day (mg/Kg/day)) was over 1,600 times greater than the child dose calculated for the site (0.031 mg/Kg/day). A NOAEL is a chemical specific dose at which no adverse health effects were observed in the study subjects (28). When converted from animal to human, with a protective factor of 100, the NOAEL would still be 16 times greater than the expected child dose.

People can also be exposed to TCE through inhalation while showering, bathing, and other activities. Inhalation exposures were calculated using the maximum value of TCE detected in private wells and assuming that 100% of the TCE was available for inhalation to develop a worst-case inhalation exposure. These calculations can be found in Appendix B. Inhalation exposures were found to be below the recommended level for acute exposure and slightly higher than the recommended level for intermediate exposure. ATSDR has not developed chronic recommendation levels for inhalation exposure to TCE. In reviewing the available animal data, the lowest NOAEL for chronic inhalation of TCE was 100 parts per million (ppm) for male rats. The study had some serious shortcomings (28). This level would be approximately 580 times greater than the calculated residential exposure dose (0.173 ppm) for this site.

In studies of humans who were exposed to TCE contaminated drinking water, varying conclusions have been reached. ATSDR has maintained a TCE Subregistry Baseline data file on approximately 5,000 persons with documented environmental exposure to TCE (along with other chemicals) through private wells. For the report, ATSDR compared health conditions reported by the TCE Subregistry registrants with health conditions reported in a nation-wide survey of the general population. Some health conditions were reported more frequently by certain age groups, and some had higher rates for only men or only women. This study did not confirm the health conditions (they were self-reported) and the study did not completely identify the exposure level. Persons in the study were exposed from 6.5 to 18 years to concentrations varying from less than 1 ppb to 19,380 ppb (determined from limited sampling data, usually one to two sampling events) (29, 30). Findings of the latest follow-up of the study indicate that subregistry participants had a reporting rate above the national norms in various age groups for speech impairment and hearing impairment for children under 10 years of age (only on the baseline study), anemia and other blood disorders, stroke, urinary tract disorders, liver problems, kidney problems, diabetes rates, and skin rashes. Although the findings of ATSDR TCE Subregistry report do not identify a cause and effect relationship between TCE exposure and adverse health effects, they do reinforce the need to continue ongoing follow-up of the participants (30).

Of the reported health problems listed above, only the rate of strokes was reported to increase with increasing concentration of TCE. For the other health problems, their occurrence did not increase with higher exposure levels. If the health problems were related with the exposure to TCE, we would expect the number of people

with a specific health problem to increase with higher levels. Therefore, it is unlikely that the reported health problems (anemia and other blood disorders, urinary tract disorders, liver problems, kidney problems, diabetes rates, and skin rashes) are associated with the exposure to TCE in private wells. Of those reporting strokes, a good portion also reported having other health problems including hypertension, diabetes, and being smokers, all of which contribute to the incidence of stroke (29).

Therefore, based on the limited groundwater sampling data available at this site (no data available on levels before 1994), significant non-cancer adverse health effects would not be expected from exposure to TCE at this site.

Carbon Tetrachloride

Carbon tetrachloride exposure through ingestion, inhalation, and dermal contact has occurred in the past, may presently be occurring at levels below its MCL, and may occur in the future for residents not connected to or outside the area of the new public water system being installed at the Pools Prairie site. Carbon tetrachloride has been detected in two private wells above the MCL (maximum 8.4 ppb) and in numerous other wells below its MCL of 5 ppb. So far, it has been found almost exclusively in Area 1 (5, 31)

Residents could have been exposed to carbon tetrachloride-contaminated groundwater since the startup of operations in 1956-57. Daily exposure doses were calculated for ingestion and inhalation exposure at the maximum value detected in water (8.4 ppb). This level was used in the calculations to develop a worst-case exposure scenario, but ingestion exposure at this level was not expected since that level was detected in August 1996 after bottled water had been provided in July 1995. These calculations can be found in Appendix B.

People can be exposed through ingestion by drinking contaminated water. Ingestion exposures were calculated to determine a maximum daily exposure dose (see Appendix B). Due to insufficient data, ATSDR does not have chronic ingestion guidelines for carbon tetrachloride (32). However, EPA has developed a chronic Reference Dose (RfD) of 0.0007 mg/Kg/day for carbon tetrachloride (33). An RfD is an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of adverse health effects for a lifetime (70 years) of exposure (34). The calculated dose for a child (0.00084 mg/Kg/day) at this site slightly exceeds the RfD. However, the comparison of the child's dose to the RfD is not applicable because a person is only a child for a few years of his or her life. Therefore, no adverse health effects from ingestion exposure to carbon tetrachloride at this site are expected.

People can also be exposed to carbon tetrachloride through inhalation. Inhalation exposures were calculated to determine a maximum daily exposure dose using the assumption that 100% of the carbon tetrachloride was available for inhalation (See Appendix B). Exposures were found to be below the recommended levels for acute and intermediate exposure. ATSDR has not developed chronic recommendation levels for inhalation exposure to carbon tetrachloride. The doses for adults and children at this site were below any NOAELs seen in animal studies (32). Therefore, significant adverse health effects would not be expected from inhalation exposure to carbon tetrachloride at this site.

Combination of Chemicals

TCE and carbon tetrachloride can affect the same human target organs (liver and kidney); therefore, the exposure to the two chemicals should be considered to be at least additive. However, given the extremely conservative assumptions used in deriving exposure doses, the likelihood of effects from the combination of chemicals would be very low. In addition, when exposure is eliminated, mild damage done to the liver and kidneys is usually repaired because of their regenerative capacity.

Cancer

The American Cancer Society estimates that 40% of the population will develop some type of cancer in their lifetime (35). DOH has calculated the cancer risk for the Pools Prairie site using the maximum detected value of contaminants for a lifetime of exposure (70 years) to develop a worst-case exposure scenario for the site. These calculations can be found in Appendix B. Overall, there may be a slightly increased risk of developing cancer from a lifetime of exposure to contaminated groundwater from this site.

The ability of TCE to cause cancer is presently under review by EPA, is classified as reasonably anticipated to be carcinogenic by the National Toxicology Program (NTP), and is classified as probably carcinogenic to humans (limited human evidence, sufficient evidence in animals) by the International Agency for Research on Cancer (IARC). ATSDR has developed a Cancer Risk Evaluation Guide (CREG) for different chemicals. CREGs are comparison values set by ATSDR to only determine if a chemical is above a level that should be further evaluated. The CREG is a level that if ingested for a lifetime at 2 liters per day, could cause one additional cancer in a population of one million ($1x10^{-6}$). A CREG for TCE is currently not available since TCE is under review by EPA (33). Humans exposed to TCE for chronic periods via the inhalation and dermal route in the workplace apparently do not experience an increased incidence of cancer. Ingestion exposure to TCE and cancer in humans is controversial, with a number of studies indicating an association and a number of studies not indicating an association (28). Results from the ATSDR TCE Subregistry exposure study did not report an excessive rate of cancer when compared with the general population (29).

Carbon tetrachloride is considered a probable human carcinogen by EPA, is reasonably anticipated to be a carcinogen by the NTP, and considered possibly carcinogenic to humans by the IARC. ATSDR currently has a CREG level of 0.3 ppb for carbon tetrachloride, for a lifetime of exposure in drinking water. Again, CREGs are used only to determine if the chemical should be further evaluated (33). Based on the levels found and conservative exposure assumptions, we do not expect a significant increased risk of developing cancer from carbon tetrachloride at this site.

Children and Other Sensitive Populations

A sensitive population will exhibit a different or enhanced response to hazardous chemicals than will most persons exposed to the same level of hazardous chemicals in the environment. Reasons may include genetic makeup, age, health and nutritional status, and exposures to other toxic substances. In general, developing fetuses are susceptible to the toxic effects of chemicals (including TCE and carbon tetrachloride) that can cross the placental barrier. The youngest of the population with immature and developing organs (i.e., premature and newborn infants and children) and the elderly with declining organ functions will be more vulnerable to toxic substances, in general, than healthy adults (27).

A number of studies have suggested or shown associations between TCE exposure and children's health effects, but these studies also had flaws which question their validity (28). These studies are discussed below.

In certain residents of Tucson, Arizona, exposed to TCE (6-239 ppb) and other contaminants (dichloroethylene and chromium) in their drinking water from certain wells, an association was found between the elevated levels of TCE in drinking water and congenital heart defects in children whose parents were exposed during the month before conception and the first trimester of pregnancy. Among children whose mothers lived in the areas receiving TCE contaminated water during the first trimester of pregnancy, the rate of congenital heart defects was two and a half times higher than among children of mothers who were not exposed to TCE during pregnancy. Moreover, the rate of congenital heart defects decreased in the previously exposed area after the contaminated wells were shut down. The most significant limitation of the report is that the exposure was ill-defined. Specifically the exact levels of exposure to individuals could not be determined, the areas that received TCE-contaminated were not clearly determined, the first year of exposure was unknown, the actual concentration of TCE varied from year-to-year (though actual

concentrations were measured in 1981), and other chemicals were present (28).

In a study of residents exposed to drinking water contaminated with solvents (including TCE at 267 ppb) in Woburn, Massachusetts, there was a suggestion that the combination of eye and ear anomalies and the combination of central nervous system, chromosomal, and oral cleft anomalies in newborns were associated with the contaminated water. However, several scientist have questioned the biological relevance of the unusual groupings of those anomalies for purposes of statistical analysis. The grouping of central nervous system disorders, chromosomal disorders, and oral cleft anomalies is questionable because they are not linked in embryological development. In addition, not enough demographic or medical background information was provided on the subjects in this study to indicate that other potential contributing factors were being considered. In addition, the study was performed following considerable publicity about the well contamination and possible health effects that could potentially affect recall bias of the participants (28).

Also in Woburn, Massachusetts, a case-control investigation (1981) and a follow-up study (1997) was conducted by the Massachusetts Department of Public Health to determine if there was an association between leukemia cases in the city and wells that supplied a portion of the city which were contaminated with TCE (267 ppb), tetrachloroethylene, low levels of other VOCs, and inorganic arsenic. The investigation concluded that the incidence of childhood leukemia was elevated in the city of Woburn and almost half of all cases occurred in the area supplied by the two contaminated wells. Also, the majority of the excess cases were male. The finding of the study suggests that the relative risk of developing childhood leukemia was greater for those children whose mothers were likely to have consumed water from the contaminated well. In contrast, there appeared to be no association between the development of childhood leukemia and the consumption of water from the contaminated wells by the children. Findings in this study are limited by the small numbers of cases and the limited information on exposures (28, 36).

Other sensitive populations including those that consume alcohol or who are treated with disulfiram (a drug used to treat alcohol dependancy) may be at greater risk of TCE poisoning. This occurs because ethanol and disulfiram can both inhibit the metabolism of TCE and cause it to accumulate in the bloodstream, potentiating its effects on the nervous system. Also, those with compromised liver and kidney function may be at a higher risk from exposure to TCE or its metabolites. The liver serves as the primary site of TCE metabolism and the kidney as the major excretory organ for TCE metabolites (28).

Those more susceptible to carbon tetrachloride toxicity include moderate to heavy drinkers, those with significant exposure to TCE and pesticides (DDT, chlordecone, PCBs, and PBBs), drugs (phenobarbitals), and diabetics. For exposure to carbon tetrachloride, no studies were located regarding developmental or reproductive effects in humans after exposure (32).

Dose calculations of past exposureat the Pools Prairie site, using the maximum level of TCE that was detected at the site (although residents are not known to have been exposed at these levels) indicate that according to the lowest adverse effect level of an animal study, the possibility of birth defects from past exposures may potentially exist. However, a review of cancer and birth record data did not reveal an increased incidence of leukemia or birth defects at this site.

Because it is difficult to predict the amount of exposure that a developing fetus may be exposed to at this site, it is also difficult to predict what birth effects or disease, if any, may result from exposure to TCE or carbon tetrachloride at this site. Women who believe they were exposed to TCE during their pregancy and are concerned about possible health impacts on the fetus, should consult their presonal physicians.

COMMUNITY HEALTH CONCERNS

Residents with contaminated private wells and those living in the contaminated areas have expressed a number of concerns during Citizen's Advisory Group (CAG) meetings and other meetings held to inform the

public about the site. This section will address the following community health-related concerns:

1. What health effects will the exposure to the contaminated well water have on me and my children in the present and in the future, such as cancer?

Based on conservative assumptions (using the highest levels of contamination detected) to calculate exposure, significant adverse health effects are not expected from known past exposure to the contaminated well water. Both TCE and carbon tetrachloride are excreted from the body and any mild effects on the liver, kidney, and nervous system are reversible after exposure ends, even after occupational exposure at levels much higher than found at the site. Cancer calculations for past exposures (made assuming that TCE is carcinogenic and exposure occurred at the maximum level and time) indicated that overall, there doesn't appear to be a significant risk of developing cancer from past exposure to contaminated groundwater at the site. However, cancer calculations were also made for a lifetime of exposure at the maximum level of contamination to those who do not connect to the public water system. Assuming 70 years of exposure to the highest level of TCE detected (310 ppb), it appears there is a potential for an elevated risk of cancer for a lifetime of exposure.

2. Has my exposure to the TCE contamination in my well been the cause of rashes, dizziness, or other symptoms?

Rashes, dizziness, as well as other symptoms from exposure (inhalation and dermal contact) to TCE and carbon tetrachloride have been seen in industry when working with pure TCE or TCE at very high concentrations. Considering that the maximum detected level was 310 ppb, it seems very unlikely that any of the mentioned health effects would be caused by the contamination in the groundwater, unless a person is sensitized to these particular chemicals. Persons having these symptoms should consult their private physicians.

3. Are my livestock being affected by drinking water from an open trough filled from a contaminated well?

It is unlikely that livestock are being affected by the low levels of contamination in their water supply. TCE and carbon tetrachloride are very volatile and evaporate quickly from surface water and surface soil. Considering the levels of contaminants present in groundwater and that, once exposed to the atmosphere, the chemicals evaporate very quickly from the watering tanks into the open air, the concentrations present for the livestock to drink would be much lower than the level present in the well water. Also, since both VOCs do not bioaccumulate (build up in the animal) and what small concentration that may get into their system is excreted (as in humans), there is no harmful effect expected to the livestock or humans that consume them.

Other concerns expressed by residents include the decline in their property values and the stigma of living near and affected by a site that is proposed for the NPL. Additional concerns include: not wanting to be annexed into the city of Neosho, a preference for individual wells, frustration with the bureaucracy, a desire for more private well sampling and faster reporting of results, not knowing what they are drinking since the level of contamination may have changed since their well was last sampled, as well as other non-health related concerns. These concerns are beyond the scope of this public health assessment and some may fall under the authority of local and regulatory agencies.

On December 14, 1999, DOH held a public availability session to present the public comment version of the Pools Prairie Site Public Health Assessment to the public and to gather and discuss any further concerns residents may have. No additional health concerns were presented in person at the meeting or received in the mail. Some technical comments were received on the document and are discussed in Appendix C.

PUBLIC HEALTH ASSESSMENT

POOLS PRAIRIE SITE
(a/k/a Neosho Wells)
NEOSHO, NEWTON COUNTY, MISSOURI

CONCLUSIONS

Residents were exposed to VOCs in their private wells for an unknown period of time until the fall of 1995 when bottled water was provided to lessen that exposure. Because contaminant levels are unknown for past exposures (possibly from 1956 until the fall of 1995), and consequently the amount of exposure residents received from their potentially VOC contaminated private wells for this time period is unknown, *the Pools Prairie site is classified as an Indeterminate Public Health Hazard for past exposures*. By April 1998, residents with contaminated private wells above or equal to the MCL had been provided a whole-house filtering system that eliminated their exposure to VOCs. The public water system, scheduled to be completed during the year 2000, will eliminate future exposures in the known and potentially contaminated areas as long as residents connect to the system. Because the exposure pathways were eliminated by the whole-house filtering system and, ultimately, by connection to the public water system, *the Pools Prairie site is currently classified as a No Apparent Public Health Hazard for residents connecting to the public water supply*. *For those not connected/connecting to the public water supply, the Pools Prairie site is currently classified as a Public Health Hazard*. *The Pools Prairie site is classified as A Public Health Hazard for the future* because: contaminated groundwater remains at the Pools Prairie site; some residents may not connect to the public water system and/or not properly maintain their whole-house filtration system; new wells may be drilled in the contaminated aquifer; the contamination plume may move or increase in concentration; and the source areas have yet to be remediated. These classifications are based on the following conclusions:

1. Due to the lack of historical data on the levels of contamination residents may have been exposed to (from possibly as early as 1956 until the fall of 1995 when the groundwater contamination was discovered), it is not possible to assess that potential exposure or its health effects. However, based on the known recent past exposures since 1995, using an extremely conservative exposure scenario, the exposure to contaminated groundwater is not believed to have caused adverse health effects from past exposures.

2. With the installation of the public water system, those residences with contaminated wells and those residents potentially affected in the areas of groundwater contamination will be assured of a safe long-term water supply, provided that residents connect to the system.

3. Residents not connecting to the public water supply and residents outside the area supplied by the new public water system could be affected in the future if their private wells become contaminated. In addition, new wells for future residences drilled in the contaminated plume may allow residents to be exposed.

4. High levels of contaminants are present at the source areas that have yet to be remediated, therefore, exposure may occur to remediation workers, trespassers, and others that may occupy or work on the site (including future construction, utility workers, etc.). Exposure could also occur if the area is developed or used for other purposes before it is completely remediated.

RECOMMENDATIONS

1. Continue to take measures to eliminate exposure to contaminated groundwater at this site.

2. Continue to take steps to mitigate the groundwater contamination.

3. Sample private wells bordering the area supplied by the new public water system on a regular basis to monitor if the contamination plume has moved and may be affecting other residents.

4. Take measures to prevent human exposure from the four source areas.

5. Ensure that remediation workers are provided with and use the appropriate personal protection equipment and follow standard health protective procedures when working with the contaminated materials.

The Missouri Department of Health will review additional information when it becomes available and respond appropriately to any request for additional information or action.

PUBLIC HEALTH ACTION PLAN

The Public Health Action Plan (PHAP) for the Pools Prairie site contains a description of actions to be taken by the Missouri Department of Health (DOH), the Agency for Toxic Substances and Disease Registry (ATSDR), and others. The purpose of the PHAP is to ensure that this public health assessment not only identifies public health hazards, but provides an action plan to mitigate and prevent adverse human health effects resulting from past, present, and/or future exposures to hazardous substances at or near the site. Included is a commitment from DOH and/or ATSDR to follow up on this plan to ensure that it is implemented. The public health actions to be implemented by DOH, ATSDR and/or cooperators are as follows:

1. DOH/ATSDR held a public availability session during the public comment period for the Pools Prairie Site Public Health Assessment (Public Comment Version) on December 14, 1999. The purpose was to present the public health assessment to the public, answer health questions they may have, and determine if there are additional health concerns. No additional health concerns were presented at the public availability session or received in the mail. Some technical comments were received and are addressed in Appendix D. The Pools Prairie Public Health Assessment will be available for public viewing at repositories in the area.

2. DOH/ATSDR will coordinate with the appropriate environmental agencies to implement the recommendations in this public health assessment.

3. DOH/ATSDR will provide follow-up to this PHAP as necessary. If a follow-up report is needed, it will be placed in the repositories that contain this public health assessment.

4. DOH/ATSDR will evaluate any further data that become available about human exposure or contaminants at the site.

5. DOH/ATSDR will discuss with the environmental agencies the need to conduct future sampling of private wells outside of the public water system to monitor the movement of the contamination plume to ensure that other residents aren't exposed.

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CERTIFICATION

The Pools Prairie Public Health Assessment was prepared by the Missouri Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved methodology and procedures existing at the time the public health assessment was initiated.

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Technical Project Officer, SPS, SSAB, DHAC

The Superfund Site Assessment Branch of the Division of Health Assessment and Consultation, ATSDR, has reviewed this public health assessment and concurs with its findings.

Lisa C. Hayes
Chief, SPS, SSAB, DHAC

PUBLIC HEALTH ASSESSMENT

POOLS PRAIRIE SITE
(a/k/a Neosho Wells)
NEOSHO, NEWTON COUNTY, MISSOURI

APPENDIX A

Figure 1: Pools Prairie Site Map

APPENDIX B

Exposure Calculations

Water Ingestion Exposure Calculations

$$IDw = \frac{C \times IR \times EF}{BW}$$

where,
IDw = ingestion exposure dose (milligram/Kilogram/day or mg/Kg/day);
C = contaminant concentration (milligram/Liter or ppm);
IR = ingestion rate (Liter/day or L/day);
EF = exposure factor
BW = body weight (Kilogram or Kg)

Trichloroethylene (TCE)

Adult:

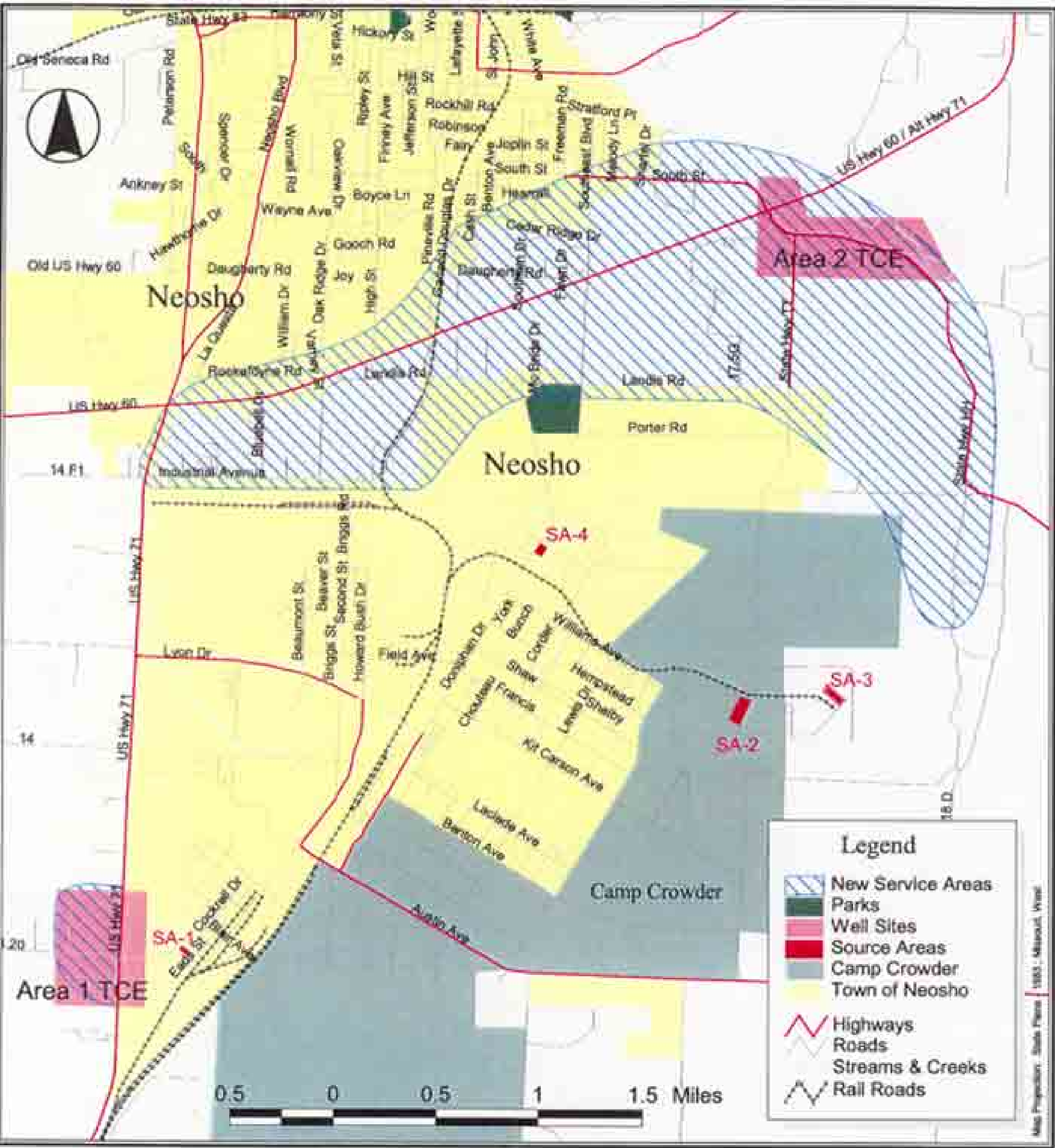
$$IDw = \frac{0.310\ mg/L \times 2L/day \times 1}{70Kg} = 0.0088\ mg/Kg/day$$

This calculation assumes that an adult weights 70 Kg (approximately 155 pounds), drinks 2 liters of tap water per day, the exposure factor is 100%, and is exposed to the maximum detected level of TCE at 310 ppb or 0.310 parts per million (ppm).

Child:

$$IDw = \frac{0.310\ mg/L \times 1L/day \times 1}{} = 0.031\ mg/Kg/day$$

Figure 1



Pools Prairie Site

Neosho, Newton County, MO

CERCLIS No. MO0000958835

Pools Prairie Site

10 Kg

This calculation assumes that a child weights 10 Kg (approximately 22 pounds), drinks 1 liter of tap water per day, the exposure factor is 100%, and is exposed to the maximum detected level of TCE at 310 ppb or 0.310 ppm.

Carbon Tetrachloride

Adult:

$$IDw = \frac{0.0084 \text{ mg/l} \times 2 \text{ L/day} \times 1}{70 \text{ Kg}} = 0.00024 \text{ mg/Kg/day}$$

This calculation assumes that an adult weights 70 Kg, drinks 2 liters of tap water per day, the exposure factor is 100%, and is exposed to the maximum detected level of carbon tetrachloride at 8.4 ppb or 0.0084 ppm.

Child:

$$IDw = \frac{0.0084 \text{ mg/l} \times 1 \text{ L/day} \times 1}{10 \text{ Kg}} = 0.00084 \text{ mg/Kg/day}$$

This calculation assumes that a child weights 10 Kg, drinks 1 liter of tap water per day, the exposure factor is 100%, and is exposed to the maximum detected level of carbon tetrachloride at 8.4 ppb or 0.0084 ppm.

Inhalation exposure from TCE and carbon tetrachloride in drinking water

In order to estimate the inhalation exposure residents of the Pools Prairie site experienced, we need to make some assumptions. These are: A person breathes in approximately 15 cubic meters of air per day, that they live in a 2,000 square foot house with three bedrooms, that there is 100% TCE and carbon tetrachloride volatilization from water, and that water usage in a home is approximately 120 gallons/bedroom.

$$\text{Inhalation Exposure} = \frac{\text{Concentration of chemical in water} \times \text{volume of water used}}{\text{Volume of air in home}}$$

Volume of water = 3 bedrooms x 120 gallons/bedroom = 360 gallons
360 gallons x 3.785 Liters/gallon = 1,363 Liters x 1 Liter/Kg = 1,363 Kg

Volume of air in home = 2,000 square feet x 8 feet height = 16,000 cubic feet
16,000 cubic feet / 35.314 = 453 cubic meters

TCE inhalation exposure:

Maximum concentration of TCE = 310 ppb = 0.310 mg/L or 0.310 mg/Kg

$$\text{Inhalation exposure} = \frac{0.310 \text{ mg/Kg} \times 1{,}363 \text{ Kg water}}{453 \text{ cubic meters}} = 0.933 \text{ mg/cubic meter}$$

$$\text{Inhalation exposure in ppm} = \frac{0.933}{5.4} = 0.173 \text{ ppm} \qquad (1 \text{ ppm TCE} = 5.4 \text{ mg/cubic meter})$$

Acute MRL = 2 ppm
Intermediate MRL = 0.1 ppm

Carbon Tetrachloride inhalation exposure:

Maximum concentration of carbon tetrachloride = 8.4 ppb = 0.0084 mg/L = 0.0084 mg/Kg

$$\text{Inhalation exposure} = \frac{0.0084 \text{ mg/Kg} \times 1{,}363 \text{ Kg water}}{453 \text{ cubic meters}} = 0.025 \text{ mg/cubic meter}$$

$$\text{Inhalation exposure in ppm} = \frac{0.025}{6.3} = 0.004 \text{ ppm} \qquad (1 \text{ ppm CT} = 6.3 \text{ mg/cubic meter})$$

Acute MRL = 0.2 ppm
Intermediate MRL = 0.05 ppm

Cancer Calculations

Formula:

$$\text{Cancer Risk} = \frac{\text{Exposure dose} \times \text{risk factor} \times \text{years of exposure}}{70 \text{ years (lifetime)}}$$

Using the assumption that TCE is carcinogenic, even though it is under review as to its carcinogenicity, the following calculation is used to approximate its risk if it would be determined to be carcinogenic.

Ingestion Exposure:

$$\text{TCE Cancer Risk} = \frac{0.0088 \text{ mg/Kg/day} \times 0.011 \times 70 \text{ years}}{70 \text{ years}} \quad \begin{matrix}\text{(risk factor = 0.011 (EPA Oral Slope Factor))}\end{matrix} = 0.000097 = 9.7 \times 10^{-5}$$

$$\text{Carbon Tetrachloride Cancer Risk} = \frac{0.00024 \text{ mg/Kg/day} \times 0.13 \times 70 \text{ years}}{70 \text{ years}} \quad \begin{matrix}\text{(risk factor = 0.13 (EPA's Oral Slope Factor))}\end{matrix} =$$

$$= 0.000031 = 3.1 \times 10^{-5}$$

Inhalation Exposure:

$$\text{TCE Cancer Risk} = \frac{0.933 \text{ mg/cubic meter} \times 0.0000017 \times 70 \text{ years}}{70 \text{ years}} \quad \begin{matrix}\text{(risk factor = 0.0000017 (unit risk))}\end{matrix} = 0.0000016 =$$

$$= 1.6 \times 10^{-6}$$

$$\text{Carbon Tetrachloride Cancer Risk} = \frac{0.025 \text{ mg/cubic meter} \times 0.000015 \times 70 \text{ years}}{70 \text{ years}} \quad \begin{matrix}\text{(risk factor = 0.000015 (unit risk))}\end{matrix} =$$

$$= 0.00000038 = 0.38 \times 10^{-6}$$

APPENDIX C

Comments and Responses on the public comment version of the Pools Prairie Public Health Assessment.

1. Page 7. The Draft Decision Document for the Engine Test Area (ETA) is used as a reference and being a draft document is subject to revision and not intended for public distribution when there are other sources for the information.

The reference for this information has been revised.

2. Page 7. The last two sentences in the first paragraph are inconsistent with the referenced document and appear to be derived from some other document.

The document has been revised.

3. Page 7. In the second paragraph, the results of the 1996 EPA sampling event are incorrectly ascribed to a 1993 report by RUST (reference 17). Also, the 4,000 ppb TCE in groundwater was actually 4,200 ppb. The information on this sampling event is in the Ecology and Environment, 1997, Removal Assessment of the Neosho Well Site.

The RUST document was incorrectly referenced. The public health assessment has been revised to reflect the proper document and the proper value of TCE.

4. Page 18. The conclusion regarding source areas exposure (both current and future) is not quantitatively supported (Conclusion 4).

The Public Health Assessment is not intended to be a quantitative document. It is assumed that as long as contamination remains at the source areas, the chance of exposure is possible.

5. Page 26. The exposure and cancer calculations are not adequately explained. The numeric results are not quantitatively interpreted.

Additional information about the exposure and cancer calculations were added to better understand why and how they were completed. The public health assessment is not intended to be a quantitative document.

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